MASTER PROJECT

Guiding light in atomically thin 2D semiconductors

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Since the isolation of graphene, other 2D materials have been discovered with exciting physical qualities. Among them, a prominent family are the monolayers of transition-metal dichalcogenides such as molybdenum disulfide (MoS₂). These monolayers exhibit many attractive properties: a transition from indirect to direct bandgap from bulk to monolayer; robust excitons at room temperature with high binding energies and strong light absorption; good quantum efficiencies in emission; and access to the spin and valley (momentum direction) degrees of freedom of electrons through the circular polarization of light. These properties create new horizons for manipulating light at the nanoscale, opening the gates to distinct physical phenomena. The research frontier between optics and 2D materials is thus proving to be of maximum scientific and technological interest.

In this project, you will demonstrate the ultimate limit of waveguiding: the possibility of guiding light bound only to an atomically thin material. To this end, you will exploit the extreme properties of excitons in transition metal dichalcogenides monolayers.

The project involves photoluminescence microscopy and spectroscopy, nanophotonic simulation techniques, cryogenics, vacuum equipment, 2D material preparation techniques.

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Figure 1. Schematic of optical waveguiding through a monolayer material. Right: optical absorption spectrum of monolayer WS₂, showing up to 16% absorption in a thickness of just 3 atoms.